REMARKS

In section 1 of the Office Action, the Examiner has required Figures 1-4 of the drawing to be labeled as prior art. Accordingly, these Figures are being amended.

In section 2 of the Office Action, the Examiner rejected claims 1, 2, and 13-16 under 35 U.S.C. §103(a) as being unpatentable over Chu in view of Yousef.

Chu describes an apparatus 100 having a feed forward filter 105, a feedback filter 150, and a training mode adaptive distortion and correlated noise canceller 110. The feed forward filter 105 utilizes equalization coefficients a(n), and the feedback filter 150 utilizes equalization coefficients b(n). The feed forward filter 105 and the feedback filter 150 comprise a decision feedback equalizer (DFE). A noise predictor 160 removes correlated noise and whitens the noise spectrum. The noise predictor 160 utilizes correlated noise reduction coefficients c(n). The coefficients a(n), b(n), and c(n) are determined during a training period in accordance with a training signal.

The apparatus 100 operates in two modes, an initial training mode followed by a data mode. During the training mode, the training mode adaptive distortion and correlated noise canceller 110 is operational, and a

filter 120, a data mode adaptive correlated noise canceller 130, and a trellis decoder 140 are bypassed. During the data mode, the filter 120, the data mode adaptive correlated noise canceller 130, and the trellis decoder 140 are operational, and the training mode adaptive distortion and correlated noise canceller 110 and the symbol decider functionality of the trellis decoder 140 are bypassed. The output of the trellis decoder 140 is a best estimate of the transmitted symbol and has a transmission delay of "p" symbols (d'(n-p)).

As shown in Figure 1 of Chu, a received signal is up sampled by a sampler 115 to provide multiple samples per symbol period. Chu states that the sampler 115 may operate either at the symbol rate or equivalently at k times the symbol rate. The samples produced by the sampler 115 are provided to the feed forward filter 105 whose output is down sampled by a down sampler 125 to the symbol rate to provide one sample per symbol period. In the data mode, the down sampled output of the feed forward filter 105 is multiplied by the transfer function (1+C(z)) in the filter 120.

In the training mode, the filter 120 is bypassed and, thus, the output of the feed forward filter 105 is combined by a summer 135 with the output of the

training mode adaptive distortion and correlated noise canceller 110 having transfer functions B(z) and C(z), with coefficients b(n) and c(n) being trained to converge to particular values.

During the data mode, the output of the filter 120 is combined by the summer 135 with the output of the data mode adaptive correlated noise canceller 130. The adaptive correlated noise canceller 130 allows the apparatus 100 to adapt to potentially changing noise conditions during the data mode.

The output of the summer 135 is provided to the trellis decoder 140 to produce a decoded output d'(n-p) during the data mode. During the training mode, the trellis decoder 140 is bypassed and is replaced by a symbol slicer 165 to produce estimated decisions (d'(n)) that are used to determine the equalization coefficients a(n) and b(n) and the correlated noise reduction coefficients c(n).

During the training mode, the coefficients a(n), b(n), and c(n) are initially determined. For subsequent pre-coding during the data mode, the coefficients b(n) and c(n) are transmitted to a transmitter. During the data mode, the coefficients a(n) and the updated coefficients c(n) continue to adapt to

potentially changing channel and noise conditions. Figure 7 shows a data mode in which pre-coding is not used.

During the training mode, an error signal 170 is determined as the difference between the output of the summer 135 and the output of the symbol slicer 165 and is used for adaptation of the feed forward filter 105 and the noise predictor 160. Also during the training mode, an error signal 185 is determined as the difference between the output of a summer upstream of the summer 135 and the output of the symbol slicer 165 and is input into the noise predictor 160.

During the data mode, the apparatus 100 adapts the feed forward filter 105 and the noise predictor 160 according to a trellis decoder error 171/172, inputs a trellis decoder error 185 into the noise predictor 160 of the data mode adaptive correlated noise canceller 130, and inputs a tentative trellis decoder error 173 into the data mode adaptive correlated noise canceller 130.

Figure 2 shows pre-coding of the transmitted symbols. Figure 3 illustrates a communication system using the equalizer and noise canceller.

Figure 5 illustrates an apparatus 102 that uses data transmission pre-coding during the data mode, and

Figure 6 illustrates an apparatus 103 that uses data transmission pre-coding during the data mode.

Figure 7 illustrates an apparatus 104 that does not uses data transmission pre-coding. The apparatus 104 is used during both of the training and data modes, and in trellis encoded applications. In the apparatus 104, the filter 120 and the feedback filter 150 are not used, and the noise predictor 160 may be implemented as a longer adaptive filter.

During the training mode, both the feed forward filter 105 and the noise predictor 160 adapt to the error 170 between the input and output of the trellis decoder 140, and the error 185 between the delayed output of the trellis decoder 140 and the delayed input to the summer 135 is provided as the input to the noise predictor 160. The delay matches the look-back depth of the trellis decoder 140 during the data mode. Following training, the correlated noise reduction coefficients c(n) of the noise predictor 160 are not reset to zero.

During the data mode, the correlated noise reduction coefficients c(n) are continuously updated to track changes and variations in the noise environment over time, and both the feed forward filter 105 and the noise predictor 160 adapt to the trellis error 195, with

an error 216 providing the input to the noise predictor 160. The trellis error 195 is equal to a branch or decision error (or branch metric) of a previous state. The error 216 is formed similarly.

Independent claim 1 - As can be seen from the above description of Chu, Chu does not disclose continuously storing input data segments of received symbols in a buffer at a symbol rate S, supplying output data sections of the received symbols from the buffer at an output rate of nS (n > 1) so that void times separate the output data sections, and calculating adjustments for a decision feedback equalizer during the void times.

The Examiner does not agree that Chu fails to disclose the supplying of output data sections of symbols at an output rate that is n times the symbol rate so that void times separate the output data sections. The Examiner points to the sampler 115 as supplying output data sections of symbols at an output rate that is n times the symbol rate so that void times separate the output data sections. Apparently, the Examiner believes that the times between output samples from the sampler 115 are the void times of independent claim 1.

The sampler 115 of Chu samples the received signal at a rate that is k times the symbol rate, where k

is a positive integer greater than one. As mentioned above, Chu states that the received signal may instead be equivalently sampled at the symbol rate. In either case, the samples are input to the feed forward filter 105, and the output of the feed forward filter 105 is down sampled to the symbol rate by a down sampler 125. (Presumably, the down sampler 125 would not be necessary if the sampler 115 samples at the symbol rate instead of at k times the symbol rate.) The samples are provided to a summer 135 whose output is decoded by the trellis decoder 140. Various outputs of the trellis decoder 140 are used to provide a feedback to the summer 135 and to calculate the coefficients of the equalizer.

There are at least several problems with the Examiner's reliance on the sampler 115 as the buffer of independent claim 1.

First, the sampler 115 does not receive symbols in segments and output the symbols in sections. Instead, the sampler 115 receives symbols and outputs samples of the symbols.

Second, the sampler 115 does not create void times between sections. The significance of the void times to the invention of independent claim 1 is that adjustments to the equalizer are calculated during the

void times. Chu attaches no significance to the spaces between samples. Therefore, Chu does not suggest using the spaces to calculate adjustments to an equalizer.

Third, although Chu calculates adjustments for a decision feedback equalizer, Chu no where discloses or suggests calculating adjustments for a decision feedback equalizer during such void times.

Fourth, Chu does not intend the sampler 115 to create void times for any purpose, much less for calculating equalizer adjustments. Chu states that the sampler 115 can equivalently sample at the symbol rate. Therefore, the amount of time between samples is irrelevant to Chu. Also, in the case where the sampler 115 is an up sampler, Chu states that the symbols are first up sampled by the sampler 115 and then down sampled by the sampler 125, reinforcing the conclusion that the amount of time between samples is irrelevant to Chu. If the amount of time between samples were useful such as for the calculation of equalizer adjustments, Chu would have suggested a purpose for the times between samples.

As can be seen and contrary to the assertion of the Examiner, Chu does not disclose receiving symbols at a first rate and outputting samples at a second rate so as to create void times between the symbols.

Because Yousef likewise fails to disclose receiving symbols at a first rate and outputting samples at a second rate so as to create void times between the symbols, one of ordinary skill in the art would not have combined Chu and Yousef so as to produce the invention of independent claim 1.

Also, the Examiner recognizes that Chu fails to disclose the buffer of independent claim 1 and, therefore, relies on Yousef. Particularly, the Examiner points to item 1820 of Figure 18, to items 1610 and 1620 of Figure 16, and to item 920 of Figure 9 of Yousef.

With regard to item 1820, Yousef states that a communication channel is characterized offline at 1810 and that this communication channel characterization is stored at 1820 such as in a buffer. Yousef elsewhere states that this channel characterization is the channel estimate. Accordingly, Yousef states that the channel estimate, not the received symbols, are stored in the buffer.

Since the buffer of independent claim 1 stores symbols and since the item 1820 relates to storing a channel estimate, this portion of Yousef is not relevant to independent claim 1.

With regard to items 920, 1610, and 1620, Yousef states that data is received at 1610 and is stored at 1620. The buffer 920 is apparently provided for this purpose. At 1630, an initial channel estimate is calculated using the received data. At 1640, a determination is made as to whether the initial channel estimate has converged. If it has, channel estimation is terminated. However, if it has not, the stored data is retrieved at 1650 and a new channel estimate is calculated at 1660.

Thus, assuming that the buffer of Yousef could be added to Chu, there is no suggestion to one of ordinary skill in the art to operate such a buffer as recited in independent claim 1.

Indeed, independent claim 1 requires the buffer to be operated so that data is output from the buffer at a rate that is greater than the rate at which data is provided to the buffer in order to create voids. According to Yousef, the buffer 920 is used solely to permit repeated calculations of the channel estimate. Using a buffer to permit repeated calculations of the channel estimate does not suggest operating a buffer in accordance with independent claim 1, i.e., so that data is output from the buffer at a rate that is greater than

the rate at which data is provided to the buffer in order to create voids.

Moreover, Chu has a sampler that can provide samples at a rate greater than the rate at which data is received. Therefore, Chu would not have suggested to one of ordinary skill in the art the addition of a buffer operating as recited in independent claim 1. Indeed, assuming that the ordinary artisan would have added a buffer to Chu, it would not have been for the purpose of outputting data a greater rate than it is received because, according to the Examiner, that function is already performed by the sampler of Chu.

Consequently, because one of ordinary skill in the art would not have combined the buffer of Yousef in Chu according to the requirements of independent claim 1, one of ordinary skill in the art would not have combined Chu and Yousef so as to produce the invention of independent claim 1.

Furthermore, the voids created by operating a buffer as recited in independent claim 1 are for the purpose of permitting calculation of equalizer adjustments during these voids. Chu and Yousef would not have suggested this purpose to one of ordinary skill in the art.

Accordingly, for this reason also, one of ordinary skill in the art would not have combined Chu and Yousef so as to produce the invention of independent claim 1.

Because one of ordinary skill in the art would not have combined Chu and Yousef so as to produce the invention of independent claim 1, independent claim 1 is not unpatentable over Chu in view of Yousef.

Because independent claim 1 is not unpatentable over Chu in view of Yousef, dependent claims 2 and 13 likewise are not unpatentable over Chu in view of Yousef.

Independent claim 14 is not unpatentable over Chu in view of Yousef for similar reasons.

Because independent claim 14 is not unpatentable over Chu in view of Yousef, dependent claims 15 and 16 likewise are not unpatentable over Chu in view of Yousef.

In section 3 of the Office Action, the Examiner rejected claims 27 and 28 under 35 U.S.C. §102(b) as being anticipated by Chu.

Independent claim 27 - Chu does not disclose calculating equalizer adjustments at least twice per segment time period.

Accordingly, Chu does not anticipate independent claim 27.

Because Chu does not anticipate independent claim 27, Chu does not anticipate dependent claim 28.

New independent claim 31 is directed to a method of operating an equalizer. Received symbols are continuously stored in a buffer at a symbol rate S and a symbol period T. Output symbols are supplied from the buffer at an output rate of nS such that void times separate corresponding pluralities of output symbols, such that n > 1, and such that each void time is greater than T. The received symbols supplied by the buffer are equalized in an equalizer to provide equalized symbols. The equalized symbols are decoded by a decoder to provide decoded symbols. Adjustments for the equalizer are calculated during the void times such that the adjustments are calculated based on both the received symbols supplied by the buffer and the decoded symbols. The adjustments are applied to the equalizer.

Neither Chu nor Yousef discloses supplying output symbols from the buffer such that void times separate corresponding pluralities of output symbols, and such that each void time is greater than the symbol period. Since the received signal is sampled according

to Chu either at the symbol rate or at greater than the symbol rate, the spacing between samples cannot be greater than the symbol period. Yousef is not at all pertinent.

Therefore, new independent claim 31 is not unpatentable over Chu alone or in view of Yousef.

Because new independent claim 31 is not unpatentable over Chu alone or in view of Yousef, new dependent claims 32 and 33 likewise are not unpatentable over Chu alone or in view of Yousef.

Because independent claim 1 is not unpatentable over Chu alone or in view of Yousef, new dependent claim 34 likewise is not unpatentable over Chu alone or in view of Yousef.

CONCLUSION

In view of the above, it is clear that the claims of the present application are patentable over the art applied by the Examiner. Accordingly, allowance of these claims and issuance of the above captioned patent application are respectfully requested.

The Commissioner is hereby authorized to charge $450 (5 additional dependent claims and 1 independent claim), and any additional fees that may be required, or to credit any overpayment, to account No. 260175.

Respectfully submitted,

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